

## **CLAIMS**

What is claimed is:

1. An electronic device, comprising:  
a redundant, hot-plug cooling fan operable to induce a flow of air through the electronic device, the cooling fan comprising:  
a fan impeller; and  
a three-phase DC motor coupled to the fan impeller.
2. The electronic device as recited in claim 1, wherein the three-phase DC motor comprises:  
a rotor coupled to the fan impeller; and  
a stator operable to receive three-phase DC power and produce a magnetic field to induce rotation in the rotor.
3. The electronic device as recited in claim 2, wherein the three-phase DC motor comprises a circuit board having a first ground plane and a second ground plane.
4. The electronic device as recited in claim 3, wherein the three-phase DC motor comprises a plurality of semiconductor switching devices selectively operable to produce three-phase DC power, the plurality of semiconductor switching devices being coupled to ground via the first ground plane.

5. The electronic device as recited in claim 3, wherein the three-phase DC motor comprises a processor coupled to the plurality of semiconductor switching devices to selectively operate the plurality of semiconductor switching devices, the processor being coupled to ground via the second ground plane.
6. The electronic device as recited in claim 3, wherein the second ground plane is electrically isolated from the first ground plane.
7. The electronic device as recited in claim 6, wherein the second ground plane is displaced on the circuit board laterally relative to the first ground plane.
8. The electronic device as recited in claim 5, wherein the circuit board comprises a plurality of terminals to enable the processor to communicate with the electronic device, wherein each of the plurality of terminals is coupled to the second ground plane.
9. The electronic device as recited in claim 8, wherein the processor selectively opens and closes the plurality of semiconductor switching devices in response to control signals received from the electronic device via a first of the plurality of terminals.
10. The electronic device as recited in claim 8, wherein the processor is operable to transmit a signal representative of a cooling fan fault to the electronic device via a second of the plurality of terminals.
11. The electronic device as recited in claim 1, comprising:  
a data storage device operable to store programming instructions; and

at least one processor operable to execute the programming instructions, wherein the data storage device and the at least one processor are cooled by the flow of air induced by the cooling fan.

12. The electronic device as recited in claim 11, comprising a second cooling fan, wherein the electronic device selectively operates both cooling fans to produce the flow of air through the electronic device.

13. A cooling fan, comprising:

an impeller;

a three-phase DC motor, comprising:

a rotor mechanically coupled to the impeller;

a stator operable to induce rotation of the rotor;

a circuit board comprising a first electrical ground and a second electrical ground electrically isolated from the first electrical ground;

a plurality of switching devices electrically coupled to the stator, wherein the plurality of switching devices are grounded via the first electrical ground; and

a processor operable to control the plurality of switching devices, wherein the processor is grounded via the second electrical ground.

14. The cooling fan as recited in claim 13, wherein the plurality of switching devices are operable to provide three-phase DC power to the stator.

15. The cooling fan as recited in claim 14, wherein the cooling fan is a hot-pluggable fan comprising a starting circuit operable to slow start the three-phase DC motor.

16. The cooling fan as recited in claim 13, wherein the first electrical ground comprises a first ground plane and the second electrical ground comprises a second ground plane.
17. The cooling fan as recited in claim 16, wherein the plurality of switching devices is displaced on the circuit board laterally relative to the processor.
18. The cooling fan as recited in claim 16, wherein the second ground plane is electrically isolated from the first ground plane by a resistor.
19. The cooling fan as recited in claim 13, wherein the rotor comprises a rare earth magnet.
20. The cooling fan as recited in claim 19, wherein the rare earth magnet comprises bonded neodymium-iron-boron.
21. The cooling fan as recited in claim 19, comprising a fan housing and a bearing assembly to couple the impeller to the fan housing, wherein each bearing in the bearing assembly has an outer diameter that is more than three times the inner diameter of the bearing.
22. A method of manufacturing a cooling fan for an electrical device, comprising;  
securing a stator of a three-phase DC motor to a circuit board;  
securing the circuit board to a cooling fan housing;  
securing the rotor of the three-phase DC motor to a fan impeller; and  
rotatably securing the rotor to the cooling fan housing.

23. The method as recited in claim 22, comprising manufacturing the circuit board for the three-phase DC motor with a first ground plane and a second ground plane electrically isolated from the first ground plane.

24. The method as recited in claim 23, comprising electrically coupling a plurality of semiconductor switching devices operable to produce three-phase DC power to the first ground plane and electrically coupling a processor operable to control the operation of the plurality of semiconductor switching devices to the second ground plane.

25. The method as recited in claim 24, wherein manufacturing a circuit board comprises forming the first ground plane and the second ground plane on a layer within the circuit board.

26. The method as recited in claim 25, wherein securing a stator comprises securing the stator to the circuit board to electrically couple the stator to the plurality of semiconductor switching devices.